ELEMENT FOR INITIATING PROPELLANT

BACKGROUND OF THE INVENTION

This invention is concerned generally with a customized low energy method of breaking rock in a controlled manner.

As used herein the word "rock" includes rock, ore, coal, concrete and any similar hard mass, whether above or underground, which is difficult to break or fracture. It is to be understood that "rock" is to be interpreted broadly.

A number of techniques have been developed for the breaking of rock using non-explosive means. These include a carbon dioxide gas pressurization method (referred to as the Cardox method), the use of gas injectors (the Sunburst technique), hydrofracturing and various methods by which cartridges containing energetic substances pressurize the walls or base of a sealed drill hole to produce penetrating cone fractures (known as PCF).

These techniques may be an order of magnitude more efficient than conventional blasting in that they require approximately 1/10 of the energy to break a given amount of rock compared to conventional blasting using explosives. The lower energy reduces the resulting quantity of fly rock and air blast and to an extent allows the rockbreaking operation to proceed on a continuous basis as opposed to the batch-type situation, which prevails with conventional blasting.

Most non-explosive rockbreaking techniques rely on the generation of high gas pressures to initiate a tensile fracture at the bottom of a relatively short drill hole.

As used herein the term “propellant” is to be interpreted broadly to include a blasting agent, propellant, gas-evolving substance, explosive or similar means which, once initiated, generates high pressure jet material typically at least partly in gaseous form. Propellants of this nature are known in the art. “Blasting agent” and “propellant” are used interchangeably in this specification.

SUMMARY OF INVENTION

The invention provides apparatus for breaking rock which includes a cartridge which forms an enclosure, a propellant inside the enclosure, and at least one element which is electrically energizable and which is made from inert material exposed to the propellant.

As used herein “inert material” means a material which, unless energized, cannot give rise to a spark or other phenomenon which can initiate the blasting agent.

The element may be in the nature of a filament or electrical resistor.

The element may be made from any appropriate material but a preferred material is carbon, eg. in the form of graphite.

The element may be treated in any appropriate way to enhance the efficiency with which the propellant is initiated. For example the element may be dipped in or coated with aluminium powder or any similar agent which gives rise to a sputtering effect when the element is energized.

The element may be in the nature of a fusible link ie. a portion of the element may disintegrate when an electric current in excess of a predetermined amount is passed through the element. Disintegration of the element gives rise to the generation of high energy and relatively small particles which are propelled into the propellant thereby to initiate combustion of the blasting agent. This approach should be contrasted with a technique wherein the element in the form of a filament wire is heated by the passage of electric current to a higher temperature at which the propellant is initiated but wherein the filament remains integral and does not disintegrate due to the direct effect of the electric current passing through the filament.

The filament may be coated to prevent the propellant, or moisture in the propellant, from reacting or fusing with the material contained in the filament.

The filament may for example be a wire or band made from aluminium, nickel-chrome, carbon or a similar material, or a resistor such as a ceramic metal device which, when energized, does not fuse or disintegrate but instead, remains integral despite dissipating sufficient heat to initiate combustion of the propellant.

The cartridge may include a base and a side wall which extends from the base. The side wall may be generally cylindrical.

The cartridge may be made from a malleable material which, in this sense, includes a material which is capable of plastic deformation, without fracture, at least to a predetermined extent.

The cartridge is preferably made from a plastics material eg. polypropylene, polyethylene or the like. The scope of the invention is not limited in this regard.

An upper end of the cartridge, ie. an end which opposes the base, may be domed and the filament may be located at the upper end.

It falls however within the scope of the invention to locate the filament at an intermediate location, i.e. between opposing ends of the cartridge.

The filament may be relatively small and thus, when energized, cause the production of a localized relatively high energy hot spot. On the other hand the filament may be elongate so that, when energized, the propellant is initiated over a fairly substantial length or area or at a plurality of points.

It falls within the scope of the invention to include more than one element in the cartridge so that initiation of the propellant takes place at more than one location. Electrical leads to the element may be positioned inside the cartridge or on an outer surface of the cartridge but preferably are embedded in the material from which the cartridge is made.

The electrical leads may be connected to terminals to facilitate connection of the leads to a control unit. The terminals are preferably on an outer side of the cartridge.

The terminals may be covered with a removable closure. Alternatively the terminals may be covered with a frangible or breakable closure. The closure is designed to protect the terminals from damage or exposure prior to use of the cartridge.

The element, or elements, as the case may be, with suitable leads or conductors to the elements and, where applicable control devices such as timing circuits and capacitors or other energy sources for operating the timing circuits, may be mounted on a suitable substrate or motherboard, to facilitate handling of these components and assembly thereof together with the remainder of the cartridge.

The invention also extends to an element of the aforementioned kind, and to a substrate which carries the element and, where required, one or more components for use with, or required to energize, the element.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described by way of examples with reference to the accompanying drawings in which:

Figure 1 is a view in cross section and from the side of blasting apparatus according to one form of the invention,

Figures 2 and 3 are views similar to Figure 1 of blasting apparatus according to second and third forms of the invention,

Figure 4 is an enlarged cross sectional view of a portion of a cartridge illustrating connecting terminals on the cartridge, and

Figure 5 shows a substrate which carries a filament for use in the apparatus of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 of the accompanying drawings illustrates a hole 10 which is drilled into a rock mass 12 from a face 14 using conventional drilling equipment. A cartridge 16 is

loaded into the hole. In this example the cartridge has a base 18 and a generally cylindrical wall 20 which extends from the base and which terminates at an upper end, remote from the base, in a rounded shape 22.

The cartridge is made from a plastics material using injection techniques which are known in the art. The cartridge is for example made from a high density plastics material such as high density polypropylene.

It is desirable to form the cartridge from a malleable material which enables the cartridge to be plastically deformed, without rupture, at least to a predetermined extent, e.g. of the order of 10%, or more.

The cartridge forms an enclosure for a propellant material 24 which is of known composition. The propellant is loaded into the cartridge under factory conditions using techniques which are known in the art.

An initiator 26 is located at an upper end of the cartridge. The initiator has an element which, in this case, is in the form of a filament made from inert material such as carbon, e.g. in the form of graphite, wire which, preferably, is formed into a coil or with a zig zag configuration. The filament extends from two leads 30 and 32 which pass through the wall of the cartridge so that filament is exposed, in the interior of the cartridge, to the propellant 24. The leads 30 and 32 extend to a blasting control unit, not shown, of a type which is known in the art.

Stemming 40 is placed into the hole from the rock face covering the cartridge to a desired extent and is consolidated by being tamped in position.

The filament is energized by sending a signal of a determined energy content through the wires 30 and 32 to the filament. The filament is thereby heated and glows creating, in effect, a localized hot spot which transfers sufficient energy to the propellant, in the immediate vicinity of the filament, to cause ignition of the propellant. The propellant, when ignited, causes the release of high pressure jet material which is substantially in gaseous form. This material produces a shock wave which is used to fracture the rock 12, typically with an initial fracture being established at the bottom 41 of the hole 10.

The carbon filament 26 is, as noted, inert and consequently it is possible to provide the cartridge 16 in a form which is ready for use in the sense that the propellant 24 can be loaded into the cartridge even though the initiator 26 is already fixed to the cartridge. In many other instances it is not possible to provide the cartridge, loaded with propellant, if the initiator is already fixed to the cartridge for it is possible inadvertently to energize the initiator and thus cause unwanted combustion of the propellant. Due to the fact that the filament is made from an inert material it is believed that this danger is effectively eliminated.

The filament may be coated with aluminum paint which, when heated, increases the quantity of energy which is released and, depending on circumstances, can give rise to a sputtering effect which enhances the efficiency with which the propellant is ignited.

The filament could alternatively be in the form of a wire or band and could be made from aluminium or nickel-chrome. These materials may be of a kind which, when heated by electric current, fuse and disintegrate. In a variation use is made of a

suitable resistor, made for example from a ceramic/metal composition which, when heated, glows but does not spatter or disintegrate, and which provides the necessary "hot spot" to initiate combustion.

The arrangement shown in Figure 2 is similar in many respect to what is shown in Figure 1 and where applicable like reference numerals are used to designate like components. The filament initiator 26 is, however, in this case located at a position more or less midway between the base 18 and the rounded upper end of the cartridge. The leads 30 and 32 extend from an upper entry point to the filament and are embedded in the wall 20 of the cartridge. The filament 26 is fired in the same way as what has been described in connection with Figure 1.

In the arrangement shown in Figure 3 the filament is not localized in the way shown in Figures 1 and 2 but, instead, is elongate. The filament extends from end points of wires 30 and 32 which, as is the case with the Figure 2 embodiment, are embedded in the side wall 20. The filament is shaped into the form of a ring which extends around an internal surface of the wall 20. Consequently, when the filament is initiated, combustion of the propellant 24 takes place over an extended length or area or, otherwise put, at a plurality of points.

The filament 26 may be designed and operated so that when energized it is heated to glow and cause a localized temperature increase of sufficient magnitude to initiate the blasting agent. Alternatively the filament may be in the form of a fusable link such that a region of the filament is heated to disintegration point by the passage of electrical current. Components of the filament which are released upon

disintegration are extremely hot and a sputtering-type action results as the filament disintegrates.

It is possible to enhance the combustion effect of the filament by coating the filament at one or more locations with an agent such as aluminum powder or any other substance which is explosive or flammable by nature. Again small localized hot spots are generated when an appropriate electrical current is passed through the filament and combustion of the propellant is therefore initiated effectively simultaneously at a plurality of locations.

Also, to protect the filament against reacting with the propellant, or moisture in the propellant, the filament may be coated with an inert material such as a suitable lacquer, e.g. of nitrocellulose.

Figure 4 is an enlarged view in cross section of an upper end 22 of a cartridge which may be of the type shown in any one of Figures 1 to 3. The leads 30 and 32 are, as has been described, embedded in the wall 20 of the cartridge and terminate in relatively rigid terminals 50 and 52 respectively, which project outwardly from the cartridge. The terminals are covered by means of a cap 54 which protects the terminals during transport and storage of the cartridge. If the terminals are to be accessed to enable electrical connections to be made to the terminals then the cap is removed. The cap may for example be threadedly engaged with the cartridge. Alternatively the cap may be formed substantially integrally with the cartridge or be secured thereto in a manner which inhibits removal of the cap. In this case the cap includes a lid 56 which is breakable, or which can be torn from the remainder along a

line of weakness, not shown, to expose the terminals so that electrical connections can be made thereto.

Figure 5 illustrates another modification which can be made to the aforementioned principles. Figure 5 shows a cartridge 10 which is filled with propellant 24. A substrate 60 is located in the cartridge. The substrate is made from an inexpensive non-electrically conductive material, and may be in the nature of a printed circuit board, be formed from a suitable plastic material, or the like. The substrate may be rigid or flexible.

Discrete components may be mounted directly to the substrate using techniques which are known in the electronics art. Alternatively components may be formed on the substrate using deposition techniques similar to those employed in the manufacture of printed circuit boards, integrated circuits and the like.

Thus, using an appropriate technique, a filament 26 is formed on, or is mounted to, the substrate and leads 62 are formed connecting the substrate to a timing circuit 64. The circuit is also formed on or bonded to the substrate and includes leads 66 which extend to terminals 68. The conductors 30 and 32, which are inherently more robust than the leads 62 and 64 on the substrate, are directly connected to the terminals.

The use of the substrate to carry the filament considerably facilitates the manufacture of the filament and its use and helps in reducing inadvertent damage to the filament which could arise during manufacture of the cartridge or when the cartridge is installed in a hole in a rock face. The substrate may be of any appropriate shape or size so that when the substrate is positioned inside the cartridge the filament 26 is substantially automatically positioned at a desired location inside the cartridge.

Clearly it is possible to form a plurality of filaments on the substrate so that the individual filaments are at precisely determined locations relatively to each other inside the cartridge.